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ABSTRACT

This document describes a Q-sort package that is seen to provide effective, easily-scored self-concept assessment which is role-specific and does not require student norms. The package is designed to provide data about student perceptions of behavior for use by researchers, mathematics supervisors, program developers, or teachers. It is noted that self-concept has long been regarded as an important dimension of education at all levels, and that the Q-sort presented could be used to investigate differences between groups of students in: (a) perceptions of behavior of ideal mathematics students; (b) self perceptions; and (c) self concept as measured by any discrepancy between ideal and self perception Q-sorts. The instrument is built around a set of 24 statements relating to the behavior of mathematics students, and uses decks of computer cards designed for analysis through computer programs. Students Q-sort the actual cards that are to be automatically processed. It is noted that additional information on this instrument's use is available, and an offer is made to put researchers who use this Q-sort in touch with each other. (MP)

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The Mathematics Student Q-Sort

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The Mathematics Student Q-Sort

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In 1965 Kremer asked junior high school teachers to choose which of a checklist of 300 adjectives those words described ideal students. The ideal female student was described as appreciative, calm, conscientious, considerate, cooperative, dependable, efficient, mannerly, mature, obliging, poised, sensitive and thorough. The ideal male student, on the other hand was adventurous, aggressive, assertive, curious, energetic, frank, enterprising, independent and inventive. While Kremer did not ask male and female students to create similar lists, it would be interesting to know just what their images of ideal students are. Perceptions of one's own strengths and weaknesses affect behavior (Purkey 1978; Rosenburg, 1979; Beane and Lipka, 1980; Parsons, 1980) and are related to achievement.

Defining the Ideal Student

Seeking significant characteristics of successful professional mathematicians and scientists, Rossi (1972) found the achiever in mathematics had high intellectual ability, was able to channel energy intensively in one direction, was independent, and was able to handle apartness from others without guilt or longing. We might expect similar qualities in the ideal mathematics students but to date we have had no information in this area. Despite the well-known race and sex differences in participation and achievement in mathematics, we do not know if adolescent females percieve the ideal mathematics student differently than do adolescent males or if minority and white adolescents have the same image of the ideal student. Students may conceptualize "ideal" differently, according to sex, race, personality differences or past history of success or failure in mathematics. Ideal student profiles might also differ by attribution patterns, influence of significant adults and peers or other factors.

Assessing Perceptions of Actual Behavior and Attitudes

Individuals with healthy self-concepts defend their values even in the face of group opposition, act with confidence on their own best judgment without feeling guilty, can acknowledge mistakes without feeling overwhelmed, and resist domination by others (Hamacheck, 1972). With respect to student self-concept in mathematics, more recent research (Holly, Purl, Dawson, and Michael, 1973; Bassham, Murphy and Murphy, 1974) has confirmed what had been hypothesized much earlier by Judd (1972): Students with a good mathematics self-concept were more positive towards the subject and assumed greater responsibility for their achievements in it. One who believes and acts as if he or she is poor at mathematics might well attribute any successes as due to luck or to extraordinary ease of the material and thus not be encouraged to participation in non-required mathematics courses. Knowing the actual as well as the ideal perceptions held by a student could give valuable data to the mathematics teacher wishing to encourage maximal participation and achievement in all students.

The Measurement of Self-Concept

"Self-concept of academic ability is taken to mean behavior in which one indicates to oneself, publicly or privately, one's ability to achieve in academic tasks as compared with others engaged in the same task" (House, 1975, p. 245). The effect of student expectancy of success or failure in mathematics achievement is not only potent (Smead and Chase, 1981) but is quite stable (Engel, 1959). It is very idiosyncratic, affected by sex (Hollander, 1972; Monge, 1973), race (Ziller, 1973) and parental expectations (Helson, 1978).

While students certainly have a general self-concept, Bilby, Brookover and Erickson (1972) suggest the utility of defining role-specific self-concept when considering decision-making. Since taking or not taking elective mathematics courses is a decision, it might be that self-concept offers a clue to differential course-taking behavior. Because self-concept cannot be directly ovserved, a variety

of strategies ranging from Likert scales to projective techniques have been developed. With respect to self-concept in mathematics, many pencil-and-paper techniques are available in mathematics (Dutton, 1951; House, 1975; Holly, Purl, Dawson and Michael, 1973; Fennema and Sherman, 1977; Burns, 1979). An alternative to pencil-and-paper instruments is the role-specific Q-Sort (Peterson and Yaakobi, 1978).

The Q-Sort Technique

The Q-Sort technique (Stephenson, 1953) is a procedure for ordering statements relative to a given criterion. In a double Q-Sort a set of items is sorted on two different criteria and then the two orderings are compared. This forced-choice instrument is quick to administer and had a high test-retest reliability (Peterson and Yaakobi, 1978). The Q-Sort can be used to compare responses within a defined group (Gough and Woodworth, 1960), between groups (Melton and Humphries, 1980; Peterson and Mayes, 1981) and within individuals over time (Engel, 1959; Kroth, 1980). While a Q-Sort violates some of the assumptions for parametric analysis (normality and independence) these effects are not serious when the sample is large (Nitzberg, 1980). Several non-parametric procedures are also appropriate for analysis (Kendall, 1975). When subjects are asked to sort the same items twice, effective comparisons between an individual's perceptions of "how it is" and "how it should be" (Stone and Green, 1971) or between "the way I am" and "the way the ideal student is" (Lee, 1972; Peterson and Yaakobi, 1978; Peterson, Kauchak and Yaakobi, 1980) can be made.

Double Q-Sort of 24 items takes only about 20 minutes to complete. The strategy requires only that the student be able to read the cards, make a judgment about how each statement pertains to the sorting criteria, and stack the cards in a pile. A roomful of students can be given the sorting task at the same time and the Q-Sort decks are reusable.

The Mathematics Student Q-Sort

The only time a Q-sort has been reported in mathematics education research was when Helson (1967) adapted a single Q-Sort used by Gough and Woodworth (1960) to develop profiles of the creative mathematician.

Following a survey of the literature on high school student participation in mathematics courses, a set of 24 statements relating to the behavior of mathematics students was generated. The set is shown in Figure 1. A deck containing the 24 statement cards and instruction card A (adopted from Peterson and Yaakobi, 1978), was then compiled. (See Figure 2). A second deck containing the same 24 statements with an instruction card requesting that the statements be sorted according to the student's perception of his or her own behavior was also compiled. Each Ideal deck bore a student ID number and the code number 1. Each Actual deck bore a student ID number and the code number 2.

Administration of the Mathematics Student Q-Sort

Once the sample is chosen, the administration of the Q-Sort is straightforward. In classroom situations, an individual student desk provides adequate space for the sorting task. The steps which were followed in the Burton, Adams, Peterson study were:

1. Each student was given an Ideal deck and a demographic sheet.
2. The directions printed on the deck were read aloud.
3. Questions about procedures were solicited and answered.
4. Students filled out the demographic sheet and sorted the Ideal deck.
5. When the sort was completed, the student brought the demographic sheet and sorted Ideal deck to the investigator.
6. The student was given the Actual deck which bore the same ID number as did his or her Ideal deck. That ID was written on the demographic sheet.
7. The Actual decks were collected as each student completed the sort.

Analysis of the Data

Student sorting provides data for the calculation of ideal and real profiles and for a comparison of individual student perceptions of these profiles. This latter is accomplished by the calculation of a correlation coefficient which reveals a self-judged distance from a self formulated ideal and is the measure of self-concept obtained from the procedure. Mean rank orders for each of the 24 items are also computed for each of the subgroups of interest. Chi-square analyses can be used to determine differences in group membership. The conservative Kruskal-Wallis Test can be used to locate significant differences in each Q-Sort rank between groups. Some groups which might be of interest are male and female students, black and white students, students receiving grades of A,B,C, D or F during the previous marking period, and students differing in attributional stances for those grades. Scoring for the Q-Sort decks is done with the computer programs written by Peterson and Yaakobi (1978) and can be found in ERIC document 163020. Significant differences can be located by using the Statistical Package for the social Science (SPSS), the Tele Storage and Retrieval System (TSAR) or any other convenient program.

Following the student sorting, the decks are readied for analysis by removing rubber bands, sequencing sorted decks in numerical order by student ID, and alternating for each subject the Ideal and Actual sorts. The computer programs developed by Peterson and Yaakobi (1978) assist in data analysis as follows:

#1: reads the sorted decks and produces two punched data cards for each subject. On each card is listed the student ID number, the code number for the sort, and a list of statement numbers in order.

#2: uses the cards generated in program #1 and calculates correlation coefficients between each subjects's two sorts and prints composite profiles of Ideal and Actual behavior for identified groups.

#3: uses the cards from program #1 and rearranges data by item statement and outputs cards to be used in program #4.

#4: performs significance tests on item mean rank differences among the groups of interest (male versus female, white versus black students, repeaters versus non-repeaters, masculine-oriented versus feminine-oriented, etc.)

As soon as program #1 has run, the Ideal and Actual decks may be shuffled and reused by another group of subjects.

The programs generate:

1. Individual Self-Concept Scores. These are indicated by the correlation coefficient (rho) calculated between the Ideal and Actual sorts. A high rho indicates a high correlation between Ideal and Actual perception and thus a high self-concept.

2. Group Scores. The mean correlation (Spearman's rho) and standard deviation, group profiles (composite sort) for both Ideal and Actual behavior are all outputs of programs #2 and #4.

3. Comparisons Among Groups. The correlation coefficients between sorts by individual and by group and significance testing of items between or among groups are available after program #4 has been run.

When all student data has been collected, a single large group of program #1 output cards can be assembled. If class or teacher comparisons are desired, each group of output cards should be identified as belonging to these subgroups in some way. I found it helpful to write demographic information directly on the face of the program #1 output cards. An example of 2 such cards can be seen in Figure 3. A 1 in column 3 indicates the Ideal sort; a 2 in that column, the Actual sort. Columns 1-2 contain the student sort ID number (There will be duplicates of these if the sort decks are reused, therefore a total group ID is necessary as well. (On the cards in figure 3, it is punched in columns 78-80). Beginning in column 5, 2 columns are allocated for each of the statement ID numbers.

This student ranked statement 13 as most indicative of the ideal student and statement 11 as most indicative of her own behavior. Demographic information used to form groups of interest is coded in columns 55 and 64 as well as written on the card. For those with access to a card sorter, the handwritten coding can be omitted. Color coding with magic markers on the edges of the cards is also helpful in sorting.

Conclusion

This Q-Sort may be used to investigate differences between groups of students in (a) perceptions of the behavior of the ideal mathematics student (b) perceptions of themselves as students and (c) self-concept scores measured by the discrepancy between Ideal and Actual Q-Sorts (Peterson, Burton and Baker, in progress; Burton, Peterson, and Baker, in progress). It has, example, been used to investigate differences between racial groups (Burton, in progress), between students who experienced success or failure in the first half of the course (Peterson, Burton and Baker, in progress) and between groups formed by using the Bem Sex Role Inventory (Burton, Adams and Peterson, in progress).

The Mathematics Student Q-Sort provides an effective, easily-scored self-concept assessment instrument which is role-specific, and which does not require external norms. It will provide data about student perceptions of behavior for use by researchers, mathematics supervisors, program developers or teachers. Self-concept has long been regarded as an important dimension of education at all levels. Investigators who wish to assess student self-concept may find the double Q-Sort described in this paper beneficial. I would be glad to furnish any additional information on its use and put researchers who use the instrument in touch with each other.

1. Reads about mathematics or applications of mathematics outside of class.
2. Thinks up original problems.
* 3. Never asks questions in class.
* 4. Memorizes formulas and proofs even when he or she doesn't understand them.
5. Knows the main ideas of algebra and geometry.
6. Expects to use mathematics in the future.
7. Does not always do as the teacher directs.
8. Helps other students having difficulty.
9. Enjoys working alone on difficult mathematics problems.
* 10. Is not confident that he or she will be able to solve mathematics exercises.
11. Is concerned about grades.
12. Completes with classmates for teacher attention.
13. Always completes all homework.
* 14. Passes in homework papers which are neat and clean.
15. Volunteers to take part in class discussions.
16. Feels tense when about to solve a difficult mathematics problem.
17. Is proud of his or her ability to solve mathematics problems and exercises.
18. Feels that people like him or her can do well in mathematics.
* 19. Feels incapable of handling mathematics assignments.
* 20. Believes success in solving mathematics exercises and problems in due to luck.
21. Makes realistic estimations of whether or not he or she will be able to do a proof or solve a problem.
22. Sometimes seems to receive a solution "out of the blue" or in a flash of insight.
23. Expects to take more mathematics courses.
* 24. Avoids taking courses which require a knowledge of mathematics.

* Negative item

Figure 1: Items on Mathematics Student Q-Sorts

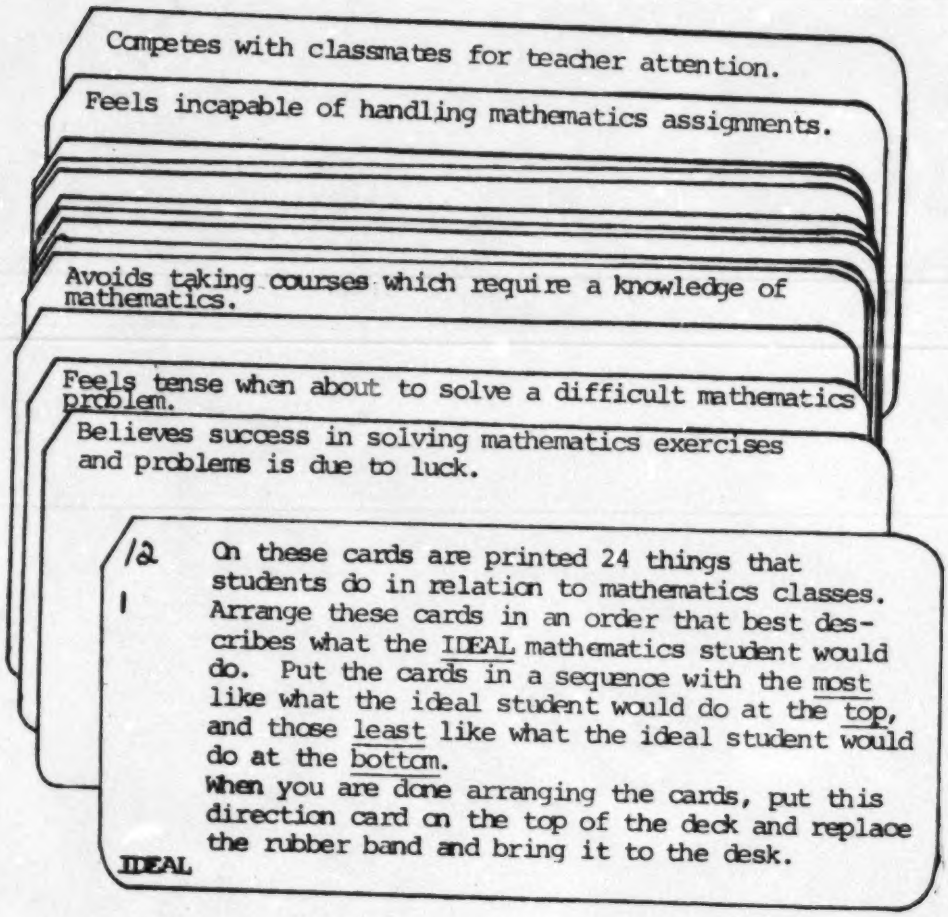
Competes with classmates for teacher attention.
Feels incapable of handling mathematics assignments.
Avoids taking courses which require a knowledge of mathematics.
Feels tense when about to solve a difficult mathematics problem.
Believes success in solving mathematics exercises and problems is due to luck.
On these cards are printed 24 things that students do in relation to mathematics classes. Arrange these cards in an order that best describes what the IDEAL mathematics student would do. Put the cards in a sequence with the most like what the ideal student would do at the top, and those least like what the ideal student would do at the bottom.
When you are done arranging the cards, put this direction card on the top of the deck and replace the rubber band and bring it to the desk.
IDEAL

Figure 2: Sample Q-Sort cards with Ideal instruction card.

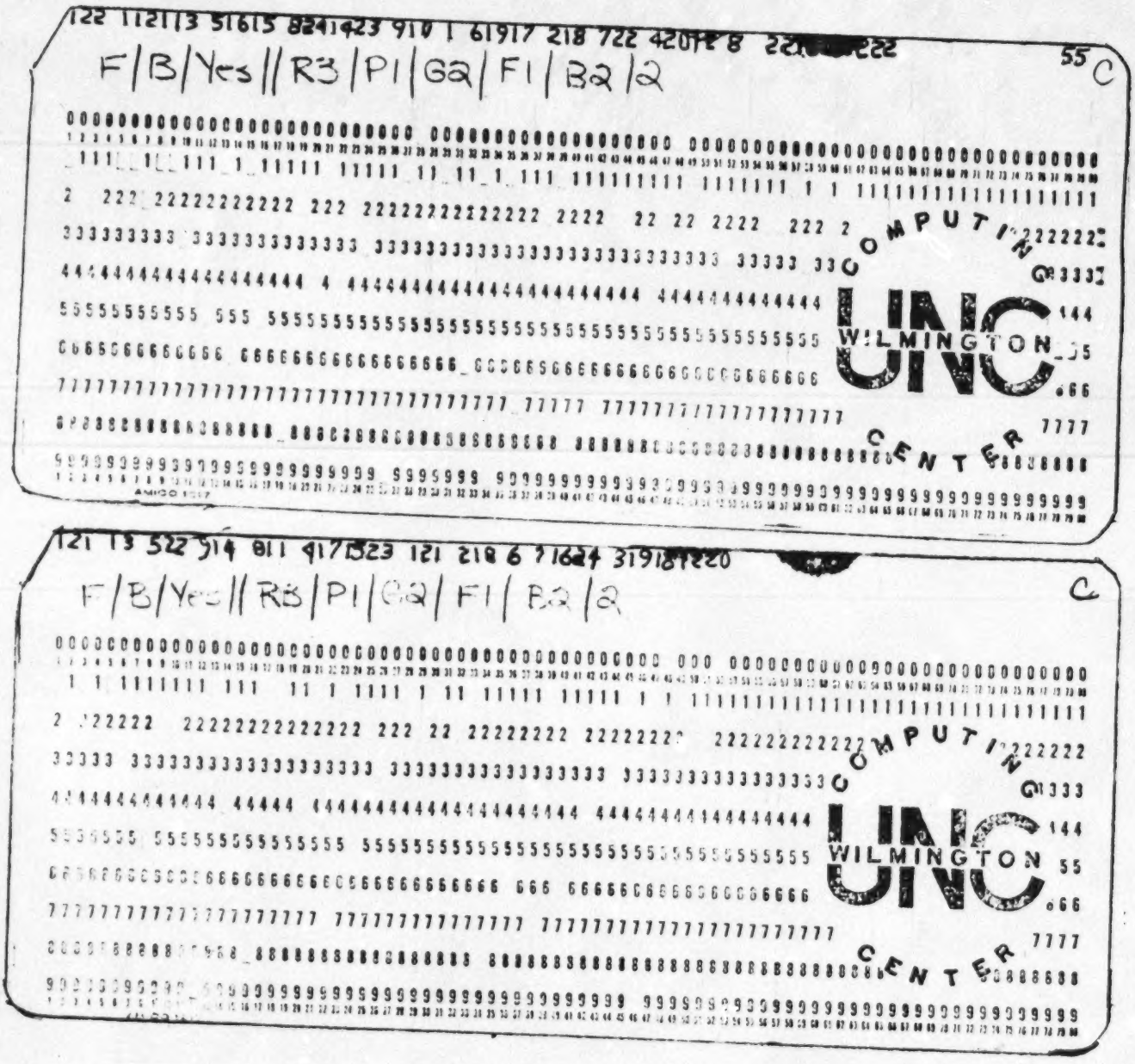

Figure 3: Program 1 output cards

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